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Claims

1. A coated article comprising a substrate having a continuous porous coating of substantially uniform thickness, wherein the coating comprises a gelled network of particles, and wherein the porous coating has two or more different compounds attached thereto.

2. A coated article according to claim 1, wherein each particle comprises one or more materials independently selected from the group consisting of carbon, activated carbon, fluorinated carbon, styrene-divinylbenzene copolymers, polystyrene, zeolites, oxides of antimony and oxides of metals present within Group III and Group IV of the Periodic Table.

3. A coated article according to claim 2, wherein each particle comprises one or more materials independently selected from the group consisting of alumina, silica, silicalite, fumed silica, oxides of tin and titania.

4. A coated article according to claim 1, wherein the particles are substantially spherical particles of silica.

5. A coated article according to claim 1, wherein the particles have a primary particle size of less than 1000Å.

6. A coated article according to claim 1, wherein the particles have a primary particle size of less than 500Å.

7. A coated article according to claim 1, wherein the particles have a primary particle size of less than 100Å.

5 8. A coated article according to claim 1, wherein the particles have a primary particle size of less than 5Å.

 9. A coated article according to claim 1, wherein the porous coating has a thickness ranging from .05 to 25 microns.

 10. A coated article according to claim 1, wherein the porous coating has a surface area that is greater than 50 meters²/g.

 11. A coated article according to claim 1, wherein the porous coating has a surface area of at least 100 square microns per cubic micron of porous coating.

15 12. A coated article according to claim 1, wherein the gelled network of particles further comprises a polymer of a hydrolyzed metal alkoxide.

 13. A coated article according to claim 12, wherein the hydrolyzed metal alkoxide has the formula:



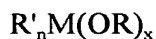
20 wherein M is selected from the group consisting of Si, Ti, Al, B, Zr, Er, Cr, Ga, Ge, Hf, Fe, Ca, Cr, La, Mg, Nb, K, Pr, Sm, Na, Ta, Te, Tl, Sn, W, V, Y, and Zn; R is hydrogen, an alkyl group or an aryl group, and x is 3 or 4.

 14. A coated article according to claim 13, wherein the hydrolyzed metal alkoxide is hydrolyzed tetraethoxysilane.

25 15. A coated article according to claim 1, wherein the substrate is glass.

 16. A coated article according to claim 1, wherein the substrate comprises an adhesive layer in contact with the porous coating.

- 5 17. A coated article according to claim 16, wherein the adhesive layer comprises one or more polymers of a hydrolyzed organo-metal alkoxide of the formula:



- wherein M is selected from the group consisting of Si, Ti, Al, B, Zr, Er, Cr, Ga, Ge, Hf,
10 Fe, Ca, Cr, La, Mg, Nb, K, Pr, Sm, Na, Ta, Te, Tl, Sn, W, V, Y, and Zn; R' is a monovalent organic group containing between 1 and 12 carbon atoms; R is hydrogen, an alkyl group or an aryl group and n and x are integers independently selected from the group consisting of 0, 1, 2, 3 and 4.

- 15 18. A coated article according to claim 17, wherein the adhesive layer comprises a polymer of hydrolyzed tetraethoxysilane.

19. A coated article according to claim 1, wherein the compounds are covalently attached to the porous coating.

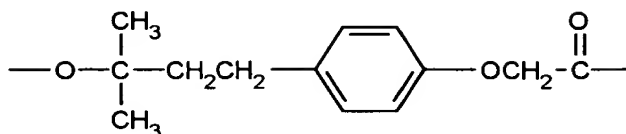
20. A coated article according to claim 1, wherein the compounds are adsorbed to the porous coating.

- 20 21. A coated article according to claim 1, wherein at least one compound is attached to the porous coating by a linker.

22. A coated article according to claim 21, wherein the linker comprises a photocleavable moiety or an enzyme cleavable moiety.

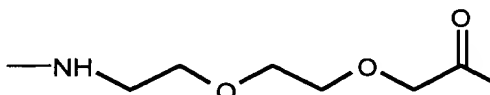
- 25 23. A coated article according to claim 21, wherein the linker comprises an acid labile moiety or a base labile moiety.

- 5 24. A coated article according to claim 23, wherein the linker comprises the formula:



25. A coated article according to claim 21, wherein the linker is an organoalkoxysilane molecule attached to the porous coating via a siloxane bond.
- 10 26. A coated article according to claim 25, wherein the linker is 3-amino-propyltriethoxysilane or bis(2-hydroxyethyl)-3-aminopropyltriethoxysilane.

27. A coated article according to claim 21, wherein the linker comprises the formula:



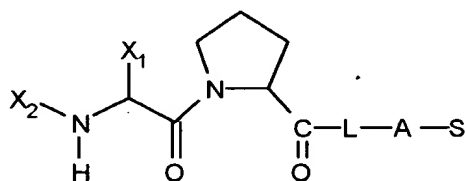
- 15 28. A coated article according to claim 1, wherein at least 90% of the compounds have the same structure.
29. A coated article according to claim 1, wherein at least 10% of the compounds have the same structure.
30. A coated article according to claim 1, wherein at least 10^3
- 20 different compounds are attached to the porous coating at known discrete full thickness volumes.

5 31. A coated article according to claim 1, wherein at least 10^5 different compounds are attached to the porous coating at known discrete full thickness volumes.

 32. A coated article according to claim 1, wherein at least 10^6 different compounds are attached to the porous coating at known discrete full thickness
10 volumes.

 33. A coated article according to claim 1, wherein the compounds are independently selected from the group consisting of nucleobase polymers and peptides.

 34. A coated article according to claim 1, comprising an enalaprilat
15 analogue of the formula:



wherein S is the porous coating, A is aminopropyltriethoxysilane, L is a divalent linker, X_1 is a monovalent organic group or hydrogen, and X_2 is a monovalent organic group or hydrogen.

20 35. A coated article according to claim 34, wherein X_1 is a monovalent organic group comprising one or more acid labile protecting groups.

 36. A coated article according to claim 34, wherein X_2 is a monovalent organic group comprising one or more acid labile protecting groups.

 37. A coated article according to claim 1, wherein the compounds
25 are attached at known discrete full thickness volumes, each occupying an area on the substrate of less than $1,000,000 \mu\text{m}^2$.

5 38. A coated article according to claim 1, wherein the compounds are attached at known discrete full thickness volumes, each occupying an area on the substrate of less than 1,000 μm^2 .

 39. A coated article according to claim 1, wherein the compounds are attached at known discrete full thickness volumes, each occupying an area on the
10 substrate of less than 10 μm^2 .

 40. A coated article according to claim 1, wherein the average pore size of the porous coating substantially approximates the primary particle size.

 41. A coated article according to claim 1, wherein the average pore size ranges from 1 to 1000 nm.
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 42. A method for making a coated article with two or more compounds attached thereto, comprising the steps of:

- (a) applying to a substrate a substantially uniform layer of a solution comprising metal oxide particles dispersed in a volatile liquid;
- 20 (b) evaporating the volatile liquid from the layer, forming a gelled network of metal oxide particles on the substrate, wherein the gelled network forms a porous coating ranging from 0.05 to 25 microns thick; and
- (c) attaching two or more compounds to discrete known regions of the porous coating, and therefrom generating a coated article comprising a substrate
25 having a porous coating with two or more compounds attached thereto.

 43. A method according to claim 42, wherein prior to the step of attaching two or more compounds, the porous coating is cured at a temperature and for a time sufficient to increase the porous coating strength.

5 44. A method according to claim 42, wherein each metal oxide particle comprises one or more materials independently selected from the group consisting of oxides of antimony and oxides of metals present within Group III or Group IV of the Periodic Table.

10 45. A method according to claim 44, wherein each metal oxide particle comprises one or more materials independently selected from the group consisting of tin oxide, titania, antimony oxide, silica, alumina, silicalite and fumed silica.

15 46. A method according to claim 42, wherein the solution comprises 0.2 to 25 weight percent of metal oxide particles with a primary particle size of less than 1000Å.

 47. A method according to claim 42, wherein the solution further comprises extended polymers of a substantially hydrolyzed metal alkoxide linked to the metal oxide particles, wherein the weight ratio of metal oxide particles to the substantially hydrolyzed metal alkoxide ranges from 1 to 1000.

20 48. A method according to claim 47, wherein the solution comprises 20 µmole to 2000 µmole of metal alkoxide per gram of metal oxide particles.

 49. A method according to claim 47, wherein the solution comprises from 60 µmole to 240 µmole of metal alkoxide per gram of metal oxide particles.

25 50. A method according to claim 47, wherein the substantially hydrolyzed metal alkoxide is substantially hydrolyzed tetraethoxysilane.

 51. A method according to claim 47, wherein the solution has a pH ranging from 4 to 5.

5 52. A method according to claim 47, wherein the volatile liquid is 70 to 90 volume percent ethanol, with the balance water.

 53. A method according to claim 47, wherein the solution is aged for greater than one day at 4°C prior to application to the substrate.

 54. A method according to claim 42, wherein the layer is cured at at
10 least 120°C for 15 minutes.

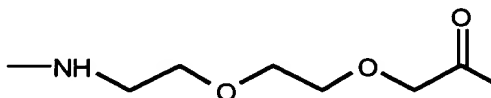
 55. A method according to claim 42, wherein at least one compound is attached to the substrate by a linker.

 56. A method according to claim 55, wherein the linker is an
15 organoalkoxysilane molecule attached to the porous coating via a siloxane bond.

 57. A method according to claim 56, wherein the linker is 3-amino-propyltriethoxysilane or bis(2-hydroxyethyl)-3-aminopropyltriethoxysilane.

 58. A method according to claim 55, wherein the linker comprises a
20 photocleavable moiety, an enzyme cleavable moiety, an acid labile moiety or a base labile moiety.

 59. A method according to claim 54, wherein the linker comprises the formula:



 60. A method according to claim 43, wherein following evaporation
25 of the volatile liquid and before the step of curing, the method comprises the steps of:

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an adhesive layer.

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generated by:

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tetraethoxysilane.

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evaporated at room temperature.

5 67. A method according to claim 64, wherein the adhesive layer is cured at at least 120°C for at least 15 minutes.

68. A method according to claim 42, wherein at least 10^4 different compounds are attached to the porous coating at known discrete full thickness volumes of the porous coating.

10 69. A method according to claim 42, wherein each of the known discrete full thickness volumes occupies an area on the substrate of less than about $10,000 \mu\text{m}^2$.

70. A method according to claim 42, wherein the compounds are attached to discrete known regions by a process comprising the steps of:

- 15 (i) attaching first molecules to the porous coating;
- (ii) covering the first molecules with a layer of photoresist;
- (iii) irradiating the photoresist such that photoresist is removed from first molecules in a first region, but not from first molecules in a second region;
- (iv) contacting first molecules from which photoresist has been removed with a first reagent, forming second molecules attached the porous coating;
- 20 and
- (v) removing remaining photoresist.

71. A method according to claim 70, wherein the photoresist is a positive photoresist comprising a polyamide.

25 72. A coated article comprising a substrate having at least two discrete known regions with continuous porous coatings, wherein each coating has a substantially uniform thickness and comprises a gelled network of particles, and wherein each porous coating has at least one compound attached thereto.

5 73. A coated article according to claim 72, wherein each particle comprises one or more materials independently selected from the group consisting of carbon, activated carbon, fluorinated carbon, styrenedivinylbenzene copolymers, polystyrene, zeolites, oxides of antimony and oxides of metals present within Group III and Group IV of the Periodic Table.

10 74. A coated article according to claim 73, wherein each particle comprises one or more materials independently selected from the group consisting of alumina, silica, silicalite, fumed silica, oxides of tin and titania.

 75. A coated article according to claim 73, wherein the particles are substantially spherical silica particles.

15 76. A coated article according to claim 72, wherein the particles have a primary particle size of less than 1000Å.

20 77. A coated article according to claim 72, wherein the continuous gelled network of particles further comprises a polymer of a substantially hydrolyzed metal alkoxide.

 78. A coated article according to claim 77, wherein the substantially hydrolyzed metal alkoxide is substantially hydrolyzed tetraethoxysilane.

25 79. A coated article according to claim 72, wherein the substrate comprises an adhesive layer.

 80. A coated article according to claim 79, wherein the adhesive layer comprises polymers of hydrolyzed tetraethoxysilane.

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82. A coated article according to claim 72, wherein each of the separate porous coatings occupies an area on the substrate of less than about 10,000 μm^2 .

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84. A coated article according to claim 72, wherein at least one compound is attached to the porous coatings via a linker.

86. A coated article according to claim 84, wherein the linker comprises a photocleavable moiety or an enzyme cleavable moiety.

87. A coated article according to claim 84, wherein the linker comprises an acid labile moiety or a base labile moiety.

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89. A coated article according to claim 72, wherein the attached compounds are selected from the group consisting of nucleobase polymers, peptides and enalaprilat analogues.

5 90. A coated article according to claim 72, wherein each of the porous coatings further comprises a fortifying layer of a polymer of hydrolyzed tetraethoxysilane.

10 91. A coated article according to claim 72, wherein the average pore size of each of the separate porous coatings substantially approximates the particle size.

 92. A method of making a coated article comprising a substrate and at least two separate porous coatings, comprising the steps of:

15 (a) applying to a substrate a substantially uniform layer of a solution comprising metal oxide particles dispersed in a volatile liquid;

 (b) evaporating the volatile liquid from the layer, forming a gelled network of metal oxide particles on the substrate, wherein the gelled network forms a porous coating ranging from 0.05 to 25 microns thick;

20 (c) covering the porous coating with a layer of photoresist comprising a base soluble component;

 (d) irradiating the photoresist, such that a first region of photoresist is rendered substantially removable with an aqueous alkaline developer, and such that a second region is not so removable;

25 (e) contacting at least the first region with an aqueous alkaline developer to remove at least the first region of photoresist and porous coating underlying the first region, without substantially removing the second region of photoresist or porous coating underlying the second region;

 (f) removing remaining photoresist with an organic solvent, resulting in separate porous coatings on discrete regions of the substrate; and

30 (g) attaching one or more compounds to each of the separate porous coatings, and therefrom generating a substrate having at least two separate porous coatings, wherein each coating has a substantially uniform thickness and comprises a continuous gelled network of metal oxide particles and polymers of a hydrolyzed metal alkoxide, and wherein each porous coating has at least one compound attached thereto.

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95. A method according to claim 92, wherein the metal oxide particles are substantially spherical particles of silica.

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97. A method according to claim 92, wherein the solution comprises 0.2 to 25 weight percent of metal oxide particles with a primary particle size of less than 500Å.

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99. A method according to claim 92, wherein the solution comprises 60 μ mole to 240 μ mole of metal alkoxide per gram of metal oxide particles.

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5 101. A method according to claim 92, wherein the solution has a pH ranging from 4 to 5.

 102. A method according to claim 92, wherein the volatile liquid is 70 to 90 volume percent ethanol, with the balance water.

 103. A method according to claim 92, wherein the solution is aged for
10 greater than one day at 4°C.

 104. A method according to claim 92, wherein the volatile liquid is evaporated at room temperature.

 105. A method according to claim 92, wherein the photoresist comprises a diazoquinone.

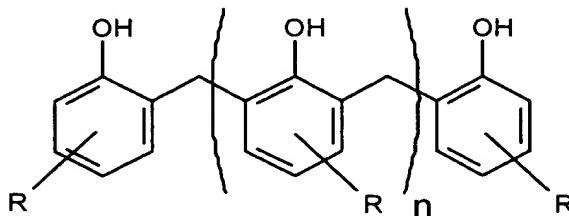
15 106. A method according to claim 92, wherein the radiation is selected from the group consisting of coherent, incoherent, x-ray, deep ultraviolet, mid ultraviolet, near ultraviolet, visible and infrared light.

 107. A method according to claim 92, wherein the step of irradiating comprises:

20 (i) placing a mask between a light source and the layer of photoresist, wherein the mask comprises first regions that transmit at least one selected wavelength of light and second regions that do not substantially transmit the selected wavelength of light.

 (ii) irradiating the mask with a light source emitting the selected
25 wavelength, such that light is transmitted to at least a first region of the layer of photoresist and is not substantially transmitted to at least the second region of the layer of photoresist.

- 5 108. A method according to claim 92, wherein the base soluble component is a phenolic polymer having the formula:



wherein R is hydrogen or an alkyl group, and n is an average ranging from 0 to 13.

- 10 109. A method according to claim 92, wherein the aqueous alkaline developer comprises a base selected from the group consisting of potassium hydroxide, sodium hydroxide and tetramethyl ammonium hydroxide.

110. A method according to claim 92, wherein the organic solvent is acetone.

- 15 111. A method according to claim 92, wherein each separate porous coating is less than 25 microns thick.

112. A method according to claim 92, wherein at least one compound is attached via a linker.

- 20 113. A method according to claim 92, wherein prior to the step of attaching one or more compounds, the separate porous coatings are cured at a temperature and for time sufficient to increase the porous coating strength.

- 25 114. A method according to claim 92, wherein following removal of remaining photoresist and before the step attaching one or more compounds, the method comprises the steps of: (i) applying a fortifying solution comprising an aged sol of hydrolyzed tetraethoxysilane in a volatile solvent to the layer of aged solution;

- 5 and (ii) evaporating the volatile solvent to yield a fortifying layer wherein the weight ratio of metal oxide particles to the hydrolyzed tetraethoxysilane ranges from 1 to 1000.

115. A method according to claim 114, wherein the fortifying solution is an aged sol comprising 0.5 volume percent tetraethoxysilane, 0.15 volume percent water, and 0.1 mM nitric acid with the balance ethanol.

- 10 116. A method according to claim 92, wherein the substrate comprises an adhesive layer of a polymer of hydrolyzed tetraethoxysilane.

117. A method according to claim 116, wherein the adhesive layer is generated by:

- 15 (i) applying onto the substrate a substantially uniform layer of an adhesive solution comprising an aged sol of hydrolyzed tetraethoxysilane in a volatile solvent; and

(ii) evaporating the volatile solvent from the layer and curing the layer to deposit a 0.002 to 2 micron thick adhesive layer of polymer of hydrolyzed tetraethoxysilane.

- 20 118. A method according to claim 117, wherein the adhesive solution is an aged sol comprising 1.5 volume percent tetraethoxysilane, 0.45 volume percent water and 0.3 mM nitric acid, with the balance ethanol.

119. A method according to claim 117, wherein the volatile solvent is evaporated at room temperature.

- 25 120. A method according to claim 117, wherein the adhesive layer is cured at at least 120°C for at least 15 minutes.

5 121. A method according to claim 92, wherein the substrate has more than 10^4 separate porous coatings in known regions, each of the porous coatings with different attached compounds.

 122. A method according to claim 92, wherein each of the separate porous coatings occupies an area on the substrate of less than about $10,000 \mu\text{m}^2$.

10 123. A method according to claim 92, wherein the photoresist is a positive photoresist.

 124. A method according to claim 92, wherein the photoresist is a negative photoresist.

15 125. A method according to claim 92, wherein the compounds are attached to discrete known regions by a process comprising the steps of:

- (i) attaching first molecules to the separate porous coatings;
- (ii) covering the first molecules by a layer of second photoresist;
- (iii) irradiating at least a portion of the second photoresist, such that second photoresist is removed from the first molecules in the first region;
- 20 (iv) contacting first molecules from which photoresist has been removed with a first reagent, forming second molecules attached to the separate porous coatings; and
- (v) removing remaining second photoresist.

25 126. A method according to claim 125, wherein the second photoresist comprises a polyamide.

 127. A method according to claim 125, wherein the second photoresist is a positive photoresist.

5 128. A method according to claim 125, wherein the second photoresist is a negative photoresist.

 129. A method of identifying at least one compound that specifically binds a receptor, the method comprising the sequential steps of:

 (a) contacting a coated article according to claim 1 or claim 72 with
10 a receptor; and

 (b) determining whether one or more of the compounds attached to the porous coating specifically bind to the receptor.

 130. A method according to claim 129, wherein each compound attached to the porous coating is independently selected from the group consisting of
15 nucleobase polymers and peptides.

 131. A method according to claim 130, wherein the compounds are antisense nucleic acid molecules.

 132. A method according to claim 129, wherein the receptor is a nucleobase polymer, enzyme, cell receptor or antibody.

20 133. A method according to claim 129, wherein the receptor further comprises a detectable marker and wherein step (b) comprises detecting a location of the marker on the porous coating.

 134. A method according to claim 133, wherein the marker is a radioactive marker or a fluorescent marker.

25 135. A method for identifying at least one compound that specifically binds a receptor, the method comprising the steps of:

 (a) simultaneously or in either order:

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(ii) contacting the detached compound(s) with a receptor; and

(b) determining whether the compound(s) specifically bind to the

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137. A method according to claim 136, wherein the linker comprises a

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139. A method according to claim 136, wherein the linker comprises a

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142. A method according to claim 135, wherein the receptor is an

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144. A method according to claim 135, wherein step (c) further comprises:

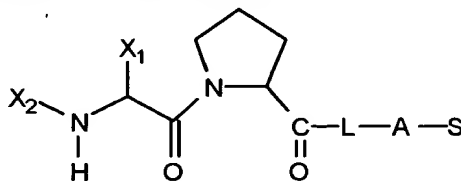
(i) contacting the receptor with an indicator compound having a
10 detectable property in the presence of receptor bound to a compound; and

(ii) determining the presence or absence of the detectable property.

145. A method according to claim 144, wherein the detectable property is selected from the group consisting of color, light absorbance, light transmission, fluorescence, fluorescence resonance energy transfer, fluorescence polarization, phosphorescence, catalytic activity, molecular weight, charge, density, melting point, chromatographic mobility, turbidity, electrophoretic mobility, mass spectrum, ultraviolet spectrum, infrared spectrum, nuclear magnetic resonance spectrum, elemental composition, and x-ray diffraction.

146. A method according to claim 145, wherein the indicator
20 compound is furylacryloylphenylalanylglycylglycine and wherein the receptor is
angiotensin converting enzyme.

147. A method according to claim 135, wherein the coated article comprises enalaprilat analogues of the formula:



25 wherein S is the porous coating, A is aminopropyltriethoxysilane, L is a divalent linker molecule, X₁ is a monovalent organic group or hydrogen, and X₂ is a monovalent organic group or hydrogen.

- 5 148. A method for isolating a target receptor, comprising the steps of:
- (a) contacting a coated article according to claim 1 or claim 72 with
a composition comprising a target receptor, wherein at least one attached compound
binds to the target receptor;
- (b) removing unbound components of the composition from the
10 array; and
- (c) separating the target receptor from the coated article, and
therefrom isolating the target receptor.

- 15 149. A coated article according to claim 1 or claim 72, wherein at
least 5% of the attached compounds comprise a target receptor modifying group that
labels, reconforms, cleaves, covalently binds or intercalates into a bound target
receptor.

- 20 150. A method for modifying a receptor, comprising contacting a
coated article according to claim 150 with a composition comprising a target receptor.

151. A method for hybridizing an antisense molecule to a target
nucleic acid molecule, comprising the steps of:
- (a) contacting a coated article according to claim 1 or claim 72 with
25 a composition comprising a target nucleic acid molecule, wherein the attached
compounds are antisense molecules; and
- (b) detaching one or more compounds from the array, and thereby
hybridizing an antisense molecule to the target nucleic acid molecule.

- 30 152. A method for hybridizing an antisense molecule to a target
nucleic acid molecule, comprising the steps of:
- (a) detaching one or more compounds from a coated article
according to claim 1 or claim 72, wherein the attached compounds are antisense
molecules; and

- 5 (b) contacting the compound(s) with a composition comprising a target nucleic acid molecule, and thereby hybridizing an antisense molecule to the target nucleic acid molecule.

10 153. A coated article according to claim 1 or claim 72, wherein the attached compounds are nucleobase polymers, wherein the nucleobase polymers comprise at least one set of 2 to 10 different probes of identical length, wherein:

15 (a) one probe is completely complementary to a 4 to 40 nucleotide portion of a reference sequence first set that is exactly complementary to a reference sequence and comprises nucleobase polymers that completely span the reference sequence and, relative to the reference sequence, overlap one another; and

20 (b) the remaining probe(s) of the set are each identical to the completely complementary probe except that each contains one nucleobase substitution relative to the completely complementary probe, wherein each substitution is at the same position relative to the reference sequence.

25 154. A coated article comprising a substrate having a continuous porous coating thereon of substantially uniform thickness, wherein the porous coating comprises a continuous gelled network of metal oxide particles and polymers of hydrolyzed metal alkoxide, wherein the porosity of the coating ranges from .15 to .99.

155. A coated article according to claim 154, wherein the metal alkoxide is tetraethoxysilane.

30 156. A coated article comprising a substrate having at least five separate distinct porous coatings per square centimeter, wherein each coating is continuous and has a substantially uniform thickness and comprises a continuous gelled network of particles.

- 5 157. A coated article according to claim 156, wherein the substrate has at least 100 separate distinct porous coatings per square centimeter.

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